

CLAIMS

- 1 1. A direct methanol fuel cell system comprising:
2 an anode, a cathode, and a membrane electrolyte disposed between the anode and
3 cathode;
4 a source of air or oxygen coupled to the cathode;
5 a source of methanol;
6 a source of water;
7 a detector for detecting changes in an output power level of said fuel cell; and
8 a methanol concentration regulator coupled to the methanol source, detector and
9 anode, said regulator responsive to changes in output power level of said cell for varying
10 the concentration of said methanol at said anode such that cross-over of methanol through
11 said membrane electrolyte is substantially minimized over a dynamic operating range.
- 1 2. The fuel cell system as in claim 1 wherein said concentration regulator is con-
2 structed using microelectromechanical system (MEMS) fabrication techniques.
- 1 3. The fuel cell system as in claim 2 wherein said concentration regulator comprises
2 a microactuator mechanically coupled to said anode and operable in response to said de-
3 tector to increase or decrease a flow of methanol to said anode.
- 1 4. The fuel cell system as in claim 3 wherein said microactuator comprises an en-
2 closed chamber mechanically coupled to a flow plate which supplies methanol to said
3 anode, said chamber being filled with a control liquid in which a resistive element is dis-
4 posed, said resistive element operable in response to said detector to heat said liquid and
5 thereby exert pressure on said flow plate.
- 1 5. The fuel cell system as in claim 2 wherein said concentration regulator comprises
2 a microactuator which is integrated with said anode.

1 6. The fuel cell system as in claim 2 wherein said concentration regulator comprises
2 a microactuator mechanically coupled to a gas diffusion layer and operable in response to
3 said detector to increase or decrease a flow of methanol to said anode.

1 7. The fuel cell system as in claim 2 wherein said concentration regulator comprises
2 a microactuator integrated with a gas diffusion layer and operable in response to said de-
3 tector to increase or decrease a flow of methanol to said anode.

1 8. The fuel cell system as in claim 1 wherein said concentration regulator is con-
2 structed using non-MEMS fabrication techniques.

1 9. The fuel cell system as in claim 1 wherein said concentration regulator is con-
2 structed using a combination of MEMS and non-MEMS fabrication techniques.

1 10. A method of regulating a concentration of methanol in a direct methanol fuel cell
2 system comprising the steps of:
3 using a detector to sense changes in an output power level of said fuel cell and
4 produce a signal indicative of said changes; and
5 using said signal to drive a concentration regulator which responsively increases
6 the amount of methanol supplied to said fuel cell's anode when said power level
7 increases, and decreases the amount of methanol supplied to said anode when said
8 power level decreases, thereby minimizing cross-over of methanol through said
9 fuel cell's membrane electrolyte.

1 11. The method as in claim 10 wherein said concentration regulator is constructed
2 using MEMS fabrication techniques.

1 12. The method as in claim 11 wherein said concentration regulator comprises a mi-
2 croactuator mechanically coupled to said anode and operable in response to said detector
3 to increase or decrease a flow of methanol to said anode.

1 13. The method as in claim 12 wherein said microactuator comprises an enclosed
2 chamber mechanically coupled to a flow plate which supplies methanol to said anode,
3 said chamber being filled with a control liquid in which a resistive element is disposed,
4 said resistive element operable in response to said detector to heat said liquid and thereby
5 exert pressure on said flow plate, whereby the flow of methanol to said anode is varied.

1 14. The method as in claim 11 wherein said concentration regulator comprises a mi-
2 croactuator integrated with said anode.

1 15. The method as in claim 11 wherein said concentration regulator comprises a mi-
2 croactuator mechanically coupled to a gas diffusion layer and operable in response to said
3 detector to increase or decrease a flow of methanol to said anode.

1 16. The method as in claim 11 wherein said concentration regulator comprises a mi-
2 croactuator integrated with a gas diffusion layer and operable in response to said detector
3 to increase or decrease a flow of methanol to said anode.

1 17. The method as in claim 10 wherein said concentration regulator is constructed
2 using non-MEMS fabrication techniques.

1 18. The method as in claim 10 wherein said concentration regulator is constructed
2 using a combination of MEMS and non-MEMS fabrication techniques.

1 19. A direct methanol fuel cell system comprising:
2 an anode, a cathode, and a membrane electrolyte disposed between the anode and
3 cathode;
4 a source of air or oxygen coupled to the cathode;
5 a source of methanol;
6 a source of water; and
7 a methanol concentration regulator, coupled to the methanol source and anode, re-
8 sponsive to changes in a potential at said anode for varying the concentration of said

9 methanol at said anode such that cross-over of methanol through said membrane electro-
10 lyte is substantially minimized over a dynamic operating range.

1 20. The fuel cell system as in claim 19 wherein said concentration regulator is con-
2 structed using microelectromechanical system (MEMS) fabrication techniques.

1 21. The fuel cell system as in claim 20 wherein said concentration regulator com-
2 prises a microactuator mechanically and electrically coupled to said anode.

1 22. The fuel cell system as in claim 21 wherein said microactuator comprises an en-
2 closed chamber mechanically coupled to a flow plate which supplies methanol to said
3 anode, said chamber being filled with a control liquid in which a resistive element is dis-
4 posed, said resistive element operable in response to said detector to heat said liquid and
5 thereby exert pressure on said flow plate.

1 23. The fuel cell system as in claim 20 wherein said concentration regulator com-
2 prises a microactuator which is integrated with said anode.

1 24. The fuel cell system as in claim 20 wherein said concentration regulator com-
2 prises a microactuator mechanically coupled to a gas diffusion layer and operable in re-
3 sponse to said detector to increase or decrease a flow of methanol to said anode.

1 25. The fuel cell system as in claim 20 wherein said concentration regulator com-
2 prises a microactuator integrated with a gas diffusion layer and operable in response to
3 said detector to increase or decrease a flow of methanol to said anode.

1 26. The fuel cell system as in claim 19 wherein said concentration regulator is con-
2 structed using non-MEMS fabrication techniques.

1 27. The fuel cell system as in claim 19 wherein said concentration regulator is con-
2 structed using a combination of MEMS and non-MEMS fabrication techniques.

28. A method of regulating a concentration of methanol in a direct methanol fuel cell system comprising the steps of:

sensing changes in potential at an anode or load level of said fuel cell system; and using said sensed changes in potential to drive a concentration regulator which responsively increases the amount of methanol supplied to said fuel cell's anode when said power level increases, and decreases the amount of methanol supplied to said anode when said power level decreases, thereby minimizing cross-over of methanol through said fuel cell's membrane electrolyte.

29. The method as in claim 28 wherein said concentration regulator is constructed using MEMS fabrication techniques.

30. The method as in claim 29 wherein said concentration regulator comprises a microactuator mechanically coupled to said anode and operable in response to said detector to increase or decrease a flow of methanol to said anode.

31. The method as in claim 30 wherein said microactuator comprises an enclosed chamber mechanically coupled to a flow plate which supplies methanol to said anode, said chamber being filled with a control liquid in which a resistive element is disposed, said resistive element operable in response to said detector to heat said liquid and thereby exert pressure on said flow plate, whereby the flow of methanol to said anode is varied.

32. The method as in claim 28 wherein said concentration regulator comprises a microactuator integrated with said anode.

33. The method as in claim 28 wherein said concentration regulator comprises a microactuator mechanically coupled to a gas diffusion layer and operable in response to said detector to increase or decrease a flow of methanol to said anode.

1 34. The method as in claim 28 wherein said concentration regulator comprises a mi-
2 croactuator integrated with a gas diffusion layer and operable in response to said detector
3 to increase or decrease a flow of methanol to said anode.

1 35. The method as in claim 28 wherein said concentration regulator is constructed
2 using non-MEMS fabrication techniques.

1 36. The method as in claim 28 wherein said concentration regulator is constructed
2 using a combination of MEMS and non-MEMS fabrication techniques.